character, that it is difficult to believe that so many minds are necessary for its construction. The contributors are Sir Herbert Maxwell, Mr. O. V. Alpin, Mr. John Cordeaux, Mr. Cecil Warburton, Dr. J. Nisbet, and Mr. C. B. Whitehead. Each tells his tale in his own way, and the editor amplifies the information here and there by means of foot-notes. Farmers will find the book a handy and simple guide, and one which will enable them to know their friends and enemies among the "varmints."

LETTERS TO THE EDITOR.

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The New Cypress of Nyasaland.

THE interesting account of *Widdringtonia whytei* (NATURE, November 22, pp. 85-87) discovered by Mr. Whyte on the Milanji plateau, suggests a few brief comments.

(1) It is said to extend "the geographical range of the genus hitherto known only from South Africa, Madagascar, and Mauritius into tropical Africa." As far as the latter statement is concerned, this is no doubt true. But the existence of any species of the genus in Madagascar or Mauritius seems to be wanting in sufficient evidence, though repeatedly cited by authorities. Thus Madagascar is given in the geographical distribution for the aggregate genus *Callitris* in Bentham and Hooker, "*Genera Plantarum*," vol. iii. p. 424; Dr. Masters, *Journ. Linn. Soc. Bot.* vol. xxx p. 17, says "one (*Widdringtonia*) has been discovered in Madagascar"; Mr. Rendle, *Trans. Linn. Soc.* (2nd series) *Bot.* vol. iv. p. 61, speaks of the "South African and Mascarene *Widdringtonia.*"

All these statements are based on a species, *Widdringtonia Commersonii*, which was *cultivated* at Réduit, Mauritius, and of which the native country was assumed to be Madagascar, though this has never been confirmed.

In 1806, it is referred to in the "Nouveau Duhamel," vol. iii. p. 10, as *Thuya quadrangularis*, with the following remark: "Habite l'isle de Madagascar; depuis quelques années ou le cultive au réduit, jardin de botanique a l'Isle de France."

The Madagascar habitat was apparently purely conjectural. And though the island has of late years been pretty assiduously worked by French, German, and English botanical collectors, no conifer has been detected in it except *Podocarpus.*

In 1833 the development of the myth went a step further. Brongniart cites the species in the *Ann. des Sc. Nat.*, series 1, vol. xxx. p. 190, under the name of *Pachylepis Commersonii*, with the remark: "Hab. in Insula Mauritii in loco dicto Le Réduit (Commerson, 1769)."

Thus it will be seen that, starting as an introduced Madagascar species cultivated in a botanic garden in Mauritius, it finishes with being treated as an undoubted native of that island.

It is, however, to be noted that from "Baker's Flora of Mauritius and the Seychelles" (1877) the *Coniferæ* appear to be entirely absent from the Mascarene Islands.

(2) There is nothing improbable in a *Widdringtonia* occurring in Madagascar. But none has yet been detected with any certainty. It seems not improbable that Commerson's plant was really derived from South Africa. This would seem to be the conclusion at which Carrière arrived in 1867, "Conifères," ed. ii. p. 67:—"Cette prétendue espèce me paraît être à peine une forme de la précédente." (*W. cupressoides*, one of the two South African species).

(3) The *Coniferæ* for the most part can hardly be regarded as other than a very ancient and a decaying group. Their existing distribution is therefore peculiarly interesting. Bentham and Hooker unite under *Callitris* a number of small genera which practically only differ in the number of their ovule-bearing scales and in their geographical distribution. They divide the genus so reconstituted into four sections, of which two are broadly Australian, two are African. Other instances of parallelism between the Australian and African floras are well known and are full of interest. Of the African sections one is confined to the north, with one species, *Callitris quadrivalvis*, which yields the gum Sandarach of modern commerce, and produced the Thyine wood once so prized by the Romans; the other section, with two species, is confined to the south. The occurrence of a third species on the Milanji highlands is entirely in harmony with what we know of the distribution of plants in Tropical Africa. As has been shown now in numerous cases, a temperate and possibly more ancient flora more or less overlies at elevations where it can exist, the lower lying tropical one, and it forms a series of broken links by which the connection of the temperate flora of Europe and of the Mediterranean basin with that of South Africa, and even of the Madagascar uplands, are at least indicated.

It may be remarked that another coniferous genus, *Podocarpus*, behaves much in the same same way as *Callitris.* Four of the five African species occur at the Cape, and two on Kilima-n'jaro. *Juniperus*, on the other hand, though well represented in Northern Africa, occurs in Abyssinia and the Masai country, but yet does not reach South Africa.

W. T. THISELTON-DYER.

Royal Gardens, Kew, December 10.

The Kinetic Theory of Gases.

I SHOULD like to ask Mr. Culverwell what are the "other considerations" from which we know that in a system of elastic spheres the error law gives the only permanent state.

I will endeavour to extend the proof of the H-theorem which I gave for elastic spheres to a more general, but not the most general, case.

The coordinates of a molecule are x, y, z, defining its position in space, and $q_1 \ldots q_{n-3}$, the momenta are $p_1 \ldots p_n$; and different values of the same variables shall be denoted by PQ and, as the case may require, by accented letters $p'\mathrm{P}'$, &c. The number per unit volume of molecules, for which the variables p and q are between assigned limits, is $f\,dq\,dp$, and f is a function of the p's and q's independent of $x\,y\,z$.

The number of pairs for which one molecule has variables P′Q′ between assigned limits, *i.e.* is in the state P′Q′, and the other $p'q'$ between assigned limits, *i.e.* is in the state $p'q'$, is $\mathrm{F}'f'a\mathrm{P}'d\mathrm{Q}'dp'dq'$.

Each molecule has a centre of gravity. It is possible to describe a sphere about that point as centre, such that if the centre of gravity of another molecule be on or beyond that sphere, no appreciable force is exerted between the two molecules. Let a be the least radius of such a sphere. Then when the centre of one molecule is on the sphere of radius a described round the centre of another, an encounter begins or ends between the two molecules.

Now suppose an encounter to take place between a pair of molecules one of which is in the state P′Q′, and the other in the state $p'q'$. As the result of the encounter the variables $\mathrm{P}' \ldots q'$ assume new values, but what particular values they shall assume, given $\mathrm{P}'\mathrm{Q}'p'q'$ before encounter, depends on the two coordinates $\theta'\phi'$ defining the position of the centre of one of the two molecules on the "a" sphere described about the centre of the other at the commencement of the encounter.

Inasmuch as no work is done in moving the centre of one molecule on the surface of this sphere, it is evident that the "sorting demons" can make the result of the encounter anything that they please, *conservatis conservandis.*

Let us suppose that if these spherical coordinates lie between the limits θ' and $\theta' + d\theta'$, ϕ' and $\phi' + d\phi'$, the variables will after encounter lie between the limits $\mathrm{P} \ldots \mathrm{P} + d\mathrm{P}$, &c., that is, the pair will be in the state $\mathrm{P}q$, and $\theta'\phi'$ will have become $\theta \ldots \theta + d\theta$ and $\phi \ldots \phi + d\phi$.

I will now assume (condition A) that the coordinates $\theta'\phi'$ are taken at haphazard without regard to the variables $\mathrm{P}'q'$; if that be so, the chance that, for given $\mathrm{P}'q'$ before encounter, the pair of molecules shall be in the $\mathrm{P}q\theta\phi$ state after encounter is $\dfrac{d\theta' d\phi'}{4\pi}$.

But the number of pairs which now are in the state $\mathrm{P}'q'$ is

$$\mathrm{F}'f'd\mathrm{P}' \ldots dq'$$

And therefore the number which after encounter will be in the state $\mathrm{P}q\theta\phi$, having passed thereto from the state $\mathrm{P}'q'$, will be

$$\mathrm{F}'f'd\mathrm{P}'d\mathrm{Q}'dp'dq'\frac{d\theta' d\phi'}{4\pi},$$

which is equal to

$$\frac{1}{4\pi}d\mathrm{P}d\mathrm{Q}dpdqd\theta d\phi \,.\, \mathrm{F}'f'.$$

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Now let $P' \ldots q'$ be made to pass through all values from which, θ' and ϕ' being suitably chosen, they can assume after encounter the given values $P \ldots P + dP \ldots q \ldots q + dq$. The final values of θ and ϕ will vary, but all possible values of θ and ϕ must appear for some or other of the values through which $P' \ldots q'$ pass, and therefore we shall by this process obtain the whole number of pairs which are in the state $P \ldots q$ after encounter, without restriction of the state which they had before encounter. It will be, namely:

$$dPdQdpdq \,. \frac{\iint F'f'dP'dQ'dp'dq'}{\iint dP'dQ'dp'dq'}$$

But the number which are in the state $P \ldots q$ now is

$$dPdQdpdqFf.$$

Therefore, as the result of encounters, it is increased by an amount proportional to

$$dPdQdpdq\int\int(F'f' - Ff)dP'dQ'dp'dq'.$$

From this point, thanks to the labours of Boltzmann and Watson, the proof is easy, and I need not repeat it, that $\frac{dH}{dt}$ is negative or zero.

I have assumed condition A. I do not say that that is the only assumption that will answer the purpose. But it is sufficient. And it is, I think, the most useful assumption, because the distribution of coordinates assumed to exist is that which would tend to be produced by any disturbances acting on the system from without.

The proof in this form is not open to the objection that by reversing the velocities we can prove two mutually contradictory propositions.

Oh, that now my friend would write a book, and point out with regard to these assumptions what more is necessary, or what less sufficient. S. H. BURBURY.

Lincoln's Inn, December 5.

P.S.—Dr. Larmor describes the reverse motions as the "exceptions which do not disprove the rule." I would apply the maxim *Exceptio probat regulam* in a slightly different sense. They are the exceptions which put the rule to the proof. They compel you to define accurately the limits within which the rule holds. When that has been done for Boltzmann's law (if it has not been done already), it will be time to consider how far the cases which fall within the law are more important than those which fall without it. S. H. B.

December 15.

THE presence of any assumption in Dr. Watson's able proof of Boltzmann's Minimum Theorem might easily be overlooked; but if Mr. Culverwell will apply his test of reversing the motions in each separate stage of the proof, he will unearth the assumption at once. On the top of p. 43 Dr. Watson says:

"And therefore the expression

$$FfdP_1 \ldots dq_{n-1}\,\dot{q}_n$$

is the number of pairs of molecules, one from each of these sets, passing from the state P, $P + dP \ldots q$, $q + dq$ to the state P', $P' + dP' \ldots q'$, $q' + dq'$ per unit of time, where q_n is put equal to 0 in f."

Now let the motion of every molecule be reversed as Mr. Culverwell suggests. It will be convenient to speak of the two states as the *unaccented* and *accented* states, and we shall thus have the assumption that the expression

$$FfdP_1 \ldots dq_{n-1}\,\dot{q}_n$$

(which is also equal to

$FfdP_1' \ldots dq'_{n-1}\,\dot{q}'_n$ but *not* to $F'f'dP_1' \ldots dq'_{n-1}\,\dot{q}_n'$)

shall represent the number of pairs of molecules passing back *from the accented to the unaccented state*, and this number will depend on F and *f*, *the frequencies of distribution which the molecules are about to have after the collisions have taken place.*

If this assumption be made we doubtless shall have a case in which H tends to a maximum instead of a minimum, and if Mr. Culverwell endows his molecules with the power of forethought and the prediction regarding their future state necessary to enable them to regulate their movements according to this suppositious law, then Dr. Watson's proof, and indeed any proof, will necessarily fall to the ground. If however the motions of the molecules are allowed to take their own natural course, and nothing special is known about them, the only reasonable assumption to make is that the number of pairs passing from the accented to the unaccented state per unit time is

$$F'f'dP_1' \ldots dq'_{n-1}\,q'_n$$

and this assumption is actually made by Dr. Watson in the next few lines of his proof that H tends to a minimum.

What Mr. Culverwell's objection shows, then, is that it is possible to conceive the molecules of a gas so projected that they would not tend to assume the Boltzmann-Maxwell distribution.

But practically it would be impossible to project the molecules in their reversed motions with sufficient accuracy to enable them to retrace their steps for more than a very few collisions, just as, if we try placing a number of pool balls in a straight line on a billiard table at distances of a foot or two apart, we find it impossible to project the first ball with sufficient accuracy for each ball to strike the next in front all down the line if there are many balls.

The question of the choice of coordinates has been so fully dealt with by Dr. Watson that I need say nothing more. However, if Mr. Culverwell prefers, he may transform from Dr. Watson's $Q_1 \ldots q_n$ to any other variables defining the position of the *pair* of molecules, *provided that he works with the corresponding generalised momenta* instead of $P_1 \ldots p_n$, and he will have no difficulty in choosing one of his *new* variables to be such that it vanishes at an encounter.

I think Lorentz's paper ("Sitzungsberichte der Wiener Akademie," 1887, p. 115) affords the fullest account of the assumptions underlying the proof of the Minimum Theorem.

Cambridge, December 5. G. H. BRYAN.

Science and History.

I SEE by your review of the *National* in the last number of NATURE, p. 162, that Prof. G. W. Prothero, in his "Address on History," takes occasion to notice Buckle's "History of Civilisation." "Buckle," he says, "in illustrating his theory that national character depends largely upon food, attributes the weakness of the Hindoos to an almost exclusive diet of rice. A striking but misleading generalisation, for, as Sir H. Maine has pointed out, the great majority of Hindoos never eat rice at all." Buckle, however, never said anything of the kind; and since no author wrote more clearly than he did, it is evident that the Professor, like many before him, has not taken this extract at first hand.

What Buckle did say was: that rice, millet, or whatever the Hindoos fed on, was grown with little trouble and in abundance; that the climate made clothes superfluous; that living was consequently cheap, and that hence the population increased beyond the demand for labour; labour was ill-rewarded, and the population became practically enslaved. I put the argument very shortly and inadequately, for any one may see it fully set forth in the "History of Civilisation," 1858, vol. i. pp. 63-74.

Sir H. Maine utterly failed to perceive that whatever might have been the food that the Hindoos lived upon, it made no difference to the argument provided that that food was cheap. He was further wrong in his statement that the Hindoos did not feed on rice, as it used to be a far more usual article of diet than in later times; but his worst mistake was to limit the argument to the people of India, who were only one people, out of many, used to illustrate the point.

ALFRED H. HUTH.

London, December 18.

Geometry in Schools.

As a mathematical teacher of long experience, I wish to state that I thoroughly agree with Prof. Henrici that experimental geometry should be taught *antecedently to* and *concurrently with* a rigorous deductive course.

Teachers who have to introduce young students to the study of deductive geometry (*to begin Euclid*, as it is called) are confronted with two difficulties. Their pupils in many cases (1) have never been seriously taught to reason about anything; (2) have no stock of geometrical ideas to reason about. The attempts made in kindergartens to give sound notions of form

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